Early Life Circumstance and Adult Mental Health

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We show that psychological well-being in adulthood varies with circumstance in early life. Combining a time series of real producer prices of cocoa with a nationally representative household survey in Ghana, we find that a one standard deviation rise in the cocoa price in early life decreases the likelihood of severe mental distress in adulthood by 3 percentage points (half the mean prevalence) for cohorts born in cocoa-producing regions relative to those born in other regions. Impacts on related personality traits are consistent with this result. Maternal nutrition, reinforcing childhood investments, and adult circumstance are likely operative channels of impact.

I. Introduction

Mental health disorders account for 13 percent of the overall global disease burden (Collins et al. 2011). The economic losses due to these disorders in low-income countries are staggeringly large: for example, depres-

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sion is estimated to generate losses of 55.5 million disability-adjusted life-years in low- and middle-income countries (Mathers, Fat, and Boerma 2008).[1] Despite these costs, in terms of both health and economic development, investment in prevention and treatment remains relatively low (Collins et al. 2011).

It is crucial, then, given the burden of mental health disorders in low-income countries, to gain a better understanding of their origins. Though there has been progress on documenting the determinants of psychological well-being (and, relatedly, satisfaction and happiness), open questions still linger (Easterlin 1974; Stevenson and Wolfers 2008). Much of the recent work in this literature studies the complex relationship between income and subjective well-being (Kahneman and Krueger 2006; Kahneman and Deaton 2010; Sacks, Stevenson, and Wolfers 2012; Stevenson and Wolfers 2013; Haushofer and Shapiro 2016). A few studies have investigated contemporaneous effects of life choices such as family and career status or residential environment (Katz, Kling, and Liebman 2001; Bertrand 2013). Still, relatively little is known about long-run determinants of mental health.

In this study, we ask, how does circumstance in early life affect psychological distress in adulthood? We focus our attention on early life influences because of the growing evidence that shocks and interventions in the early period of life have large, lasting impacts on health and human capital formation (Heckman 2006, 2007; Almond and Currie 2011). We examine this relationship using a nationally representative household survey from Ghana. This includes a module comprising the Kessler Psychological Distress Scale (K10), an internationally validated measure of anxiety-depression spectrum mental distress (Andrews and Slade 2001; Kessler et al. 2002). We exploit variation in early life conditions induced by changes in the real producer price of cocoa. Cocoa is Ghana's chief agricultural export commodity, and its price is a key determinant of household incomes in the regions where it is grown.[2]

We show that in cocoa-producing regions of Ghana, low cocoa prices at the time of birth substantially increase the incidence of severe mental

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[1] In Ghana, where our study is based, Canavan et al. (2013) estimate that the productivity loss associated with mental illness is equivalent to 7 percent of the country's GDP.

[2] Poverty reduces nutritional availability in utero and affects mothers' stress levels and cognitive functioning, all of which in turn affect fetal programming (Almond and Currie 2011; Mani et al. 2013; Persson and Rossin-Slater 2018).

distress, as classified by the Kessler Scale. A one standard deviation drop in the cocoa price increases the probability of severe mental distress by 3 percentage points, or nearly 50 percent of mean severe distress incidence, in cohorts born in cocoa-producing regions relative to those born in other regions of Ghana. Effects on related personality traits show remarkable consistency with the Kessler Scale results. The impact on mental health is robust to changes in specification, type of shock, and choice of aggregation of the K10 survey questions.

What drives the long-lasting impacts on mental health we find? Beyond the direct physiological effects of nutritional availability in utero (Shonkoff et al. 2012), we examine several additional potential mechanisms. We look first to the most proximate outcome: maternal health. Using Demographic and Health Survey (DHS) data from Ghana, we show that cocoa prices positively predict (contemporaneous) maternal weight and body mass index (BMI), which are highly correlated with birth weight and health in infancy (Gunnsteinsson et al. 2018). Additionally, we find that parents reinforce these increases in initial endowments by increasing vaccination rates and breast-feeding for longer.[3] Next, we look at adult physical health and economic outcomes. We find mixed evidence here: health stock, as measured by adult height, significantly improves with higher cocoa prices at birth, but indicators of economic circumstance (savings and occupation type) are not significantly higher.

Finally, we check for selective mortality and fertility and find that both respond to price shocks. On average, child mortality and fertility are both procyclical.[4] We then study, in three ways, the extent to which selective mortality and fertility might be driving our results on mental health. First, we control for maternal and paternal characteristics (educational attainment and occupation dummies) and find no change in the size of the estimated impacts on mental health. Second, we use a household fixed effects strategy to control for unobservable determinants of selection that vary at the (current) household level and find that the impact on severe mental distress gets stronger after controlling for these effects. Third, to check the extent to which the pattern of results is preserved in the absence of endogenously inflated cohorts due to selection bias, we use frequency weights to deflate the importance of high-price, low–mental distress observations. After reweighting observations in this way for various intensities of selection bias, we find similar impact coefficients compared to the baseline results, suggesting that selection bias does not play a major role in our context. However, because we do find that fertility and child mortality are procyclical and because the price treatments we consider do

[3] This reinforcement behavior is consistent with recent results from both developed and developing countries (Almond, Edlund, and Palme 2009; Adhvaryu and Nyshadham 2016).

[4] The finding that mortality and crop income are positively related is echoed in the study by Miller and Urdinola (2010), who study infant mortality and coffee prices in Colombia.

not have sharp and precise timing, we cannot claim that the role of selection bias is wholly nonexistent.

Our study is closely related to the "fetal origins" literature in economics. The fetal origins hypothesis—that access to nutrition in early life has long-run effects on health and well-being—has been affirmed and extended by a large body of empirical evidence in economics.[5] These studies show that changes in fetal programming can affect a wide variety of outcomes, including physical health (Currie 2009; Hoynes, Schanzenbach, and Almond 2012); IQ, educational performance, and attainment (Bleakley 2007; Aizer and Cunha 2012; Bharadwaj, Løken, and Neilson 2013); and labor market outcomes (Almond 2006; Bleakley 2010; Gould, Lavy, and Paserman 2011; Bhalotra and Venkataramani 2012).

Apart from being a key determinant of utility and an important endpoint in its own right (Kahneman and Deaton 2010; Daly, Wilson, and Johnson 2013), mental health is also a potential mechanism through which some of the previously documented fetal origins impacts on health and human capital may arise (Kubzansky et al. 1997, 1998; Whang et al. 2009).[6] Moreover, medical evidence suggests that some components of mental health are coded during fetal development (Shonkoff 2011; Shonkoff et al. 2012). Changes to the fetal environment, if they alter or disrupt this coding process, may have long-lasting impacts on mental health (Huttunen and Niskanen 1978; Mednick et al. 1988; Neugebauer, Hoek, and Susser 1999).[7]

Few studies in economics have examined the causal impacts of early life stressors on mental health.[8] In economics, perhaps the most closely related work is the recent study by Persson and Rossin-Slater (2018), who study the effects of maternal stress caused by deaths of close family members, finding large increases in prescription drug usage for mental health disorders in childhood and adulthood for exposed individuals. Our study is also related to those by Almond and Mazumder (2011), who find that the likelihood of mental disability increases with periods of religious fasting during early pregnancy, and Dinkelman (2017), who finds that

[5] Barker's original contributions (1990) related to long-term impacts on heart disease, and the subsequent literature in economics and other disciplines is nicely reviewed in Almond and Currie (2011) and Currie and Vogl (2013).

[6] It bears mentioning, as we discuss later in the paper, that effects may not be due to in utero exposure alone; we cannot statistically reject the impacts of prices in the perinatal period more generally.

[7] Stress affects the "architecture" of the developing brain. In particular, it leads to hypertrophy of the amygdala and neural connection loss in the hippocampus and prefrontal cortex. These changes, in turn, affect a whole host of outcomes related to psychosocial and executive functioning (Shonkoff et al. 2012).

[8] There is a rich literature in public health studying the impacts of extreme caloric deprivation during gestation on adult mental health; see, e.g., Susser and Lin (1992); Brown et al. (1995, 2000); Hoek et al. (1996); Hoek, Brown, and Susser (1998); Neugebauer et al. (1999); Pol et al. (2000); Huang et al. (2013). This evidence focuses overwhelmingly on the impacts of severe famines, particularly on the case of the Dutch Winter Famine of 1944–45.

drought shocks can generate long-term mental health effects. Our work complements these previous studies in economics and public health by examining not only the effects of extreme deprivation and acute stress but also the impacts of moderate exposure to these early insults.

Our focus on psychological well-being is related to a growing literature on the determinants of personality and noncognitive skill formation (Heckman 2007; Cunha, Heckman, and Schennach 2010). Recent studies emphasize the importance of early investments in children for the formation of noncognitive skills such as motivation, perseverance, and dependability (Heckman 2006). Indeed, these personality traits are linked to economic outcomes independent of traditional cognitive ability measures such as IQ (Heckman and Rubinstein 2001; Heckman, Stixrud, and Urzua 2006). We add to this work by demonstrating that early life conditions have large (causal) effects on psychological well-being and related personality traits. We also expand the body of evidence in this area by looking in a developing country setting; most previous studies use data from the United States.

As a growing segment of the fetal origins literature has already documented, early life trauma can have outsized impacts in low-income populations whose income smoothing and coping mechanisms are often limited. In particular, smallholder farm households in the developing world are exposed to frequent income fluctuations (Townsend 1994; Maccini and Yang 2009). The households we focus on (cocoa farmers), and millions like them, are commodity suppliers to the global market (Deaton 1999). The wide and persistent price fluctuations that characterize these markets directly affect the livelihoods of smallholder suppliers, leaving households (and young children in particular) vulnerable to the deleterious effects of shocks (Benjamin and Deaton 1993; Kruger 2007; Miller and Urdinola 2010; Cogneau and Jedwab 2012; Adhvaryu, Kala, and Nyshadham, forthcoming). It is crucial, then, to study whether income shocks and their consequences constitute part of the origins of mental distress in low-income contexts, in order to devise policy solutions that address this problem.[9]

The rest of the paper is organized as follows. In Section II, we outline our empirical strategy. Section III describes the cocoa price data and our survey data. Section IV discusses our results, and Section V presents conclusions.

II. Empirical Strategy

A. *Intuition*

The intuition for our identification strategy is that households in the cocoa-producing regions of Ghana experience changes in the real producer price of cocoa as income shocks, while households in regions that do not pro-

[9] In this respect, our study is related to recent work documenting the short- and medium-run mental health impacts of natural disasters and crises (Frankenberg et al. 2008; Friedman and Thomas 2009; Rhodes et al. 2010; Paxson et al. 2012).

duce cocoa are unaffected by these fluctuations. Children born into households in cocoa-growing regions during periods of high cocoa prices will have more resources, owing both to the higher incomes of cocoa-producing households and to the dependence of nonagricultural activities in these regions on the cocoa sector. These resource booms could have large and lasting impacts on mental health through their effects during both gestation and infancy.

B. Motivation

To motivate this identification strategy, we present a graph in figure 1 that depicts the correlation between cocoa price shocks during an individual's year of birth and his mental health in later life. The solid line is the 3-year moving average of the log of the real producer price of cocoa. The dotted line is the 3-year moving average of the difference between the incidence of severe mental distress among individuals born in Ghana's cocoa-producing regions and its incidence among individuals born in the rest of Ghana. A clear negative correlation between the two time series is evident. That is, individuals born in the cocoa-producing regions of Ghana when incomes of cocoa producers are high show low rates of severe mental distress relative to individuals born in the same year but in parts of Ghana that do not grow cocoa. When incomes in cocoa-producing regions fall, the pattern is reversed.

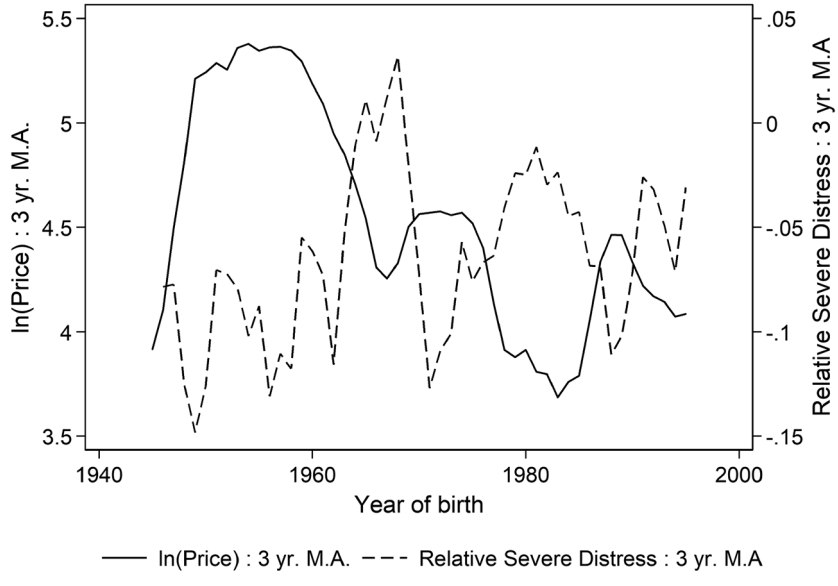

FIG. 1.—Cocoa prices at birth and severe distress

C. *Specification*

To test for the effects of cocoa price fluctuations in the year of birth on later-life mental health, we estimate the following equation:

$$\begin{aligned}\text{Outcome}_{irt} = \alpha + \beta \ln(\text{Cocoa Price}_t) \times \text{Cocoa Producer}_r \\ + x'_{irt}\gamma + \delta_r + \eta_t + \epsilon_{irt}.\end{aligned} \tag{1}$$

Here, Outcome_{irt} is the outcome for individual i, born in region r in year t. In the main results reported in table 2 below, we will use either the natural log of the individual's response on the 10-question Kessler Psychological Distress Scale or, in keeping with the convention when analyzing Kessler scores, a dummy for whether the individual's score was 30 or above as an indicator for severe distress. Cocoa Price_t is the real producer price of cocoa in year t. We describe the source of the price data used and how the real producer price is calculated in Section III. Cocoa Producer_r is an indicator for whether cocoa is produced in region r. We discuss how this indicator is defined in Section III. The coefficient of interest is β. We anticipate that the effect of beneficial shocks to parental income will reduce adult mental illness, leading to negative estimates of β. Throughout, we will refer to this composite variable $\ln(\text{Cocoa Price}_t) \times \text{Cocoa Producer}_r$ as the "price shock."

The term x_{irt} is a vector of controls. In our preferred specification, this will include female, household head, the interaction of female and head, dummies for religion, and dummies for ethnicity. The terms δ_r and η_t are vectors of fixed effects for year and region of birth, respectively, and α is an intercept. In our baseline, we will cluster standard errors by enumeration area. This is the primary sampling unit of the outcome variables. As robustness checks, we will cluster, alternately, by region of birth or by year of birth. In addition to these, we also report Cameron, Gelbach, and Miller (2011) standard errors clustered by both enumeration area and year of birth, or alternately by region of birth and year of birth.

Our preferred specification includes an additional vector of controls: $\delta_r \times t$. This set of controls interacts the vector of region of birth fixed effects δ_r with a continuous year of birth variable t to allow for region of birth–specific time trends.[10] We also add quadratic region of birth–specific time trends in subsequent robustness checks.

We include rainfall and temperature measures in the region as additional controls in a later specification. To the degree that the price shock variable is picking up region-specific fluctuations in temperature or rainfall, effects on mental health outcomes could be due to direct effects of

[10] These trends are included primarily to absorb irrelevant variation over time in the outcome variable at the region of birth level.

these fluctuations on health of the mother or other members of the household, in addition to household income fluctuations.

III. Data

In this section, we describe the data sources used in the analysis. Additionally, where necessary, we describe the construction of the variables of interest.

A. *Cocoa Prices and Production*

Our source of data for real producer prices of cocoa is Teal (2002). He calculates these using the following:

$$\frac{P_X^P}{P^C} = \frac{P_X}{P_M}\frac{P_M ER}{P^C}(1 - t).$$

Here, P_X^P is the cedi price received by cocoa producers, which is deflated by P^C, the price of domestic goods. This can be reexpressed as a function of P^X, the export price in foreign currency, P^M, the price of imports in foreign currency, ER, the official exchange rate, and the tax rate t, which encompasses both export duties and the difference between world cocoa prices and the lower prices often set by the monopolistic cocoa board. This real producer price represents a time-varying income opportunity available to households in the cocoa-growing regions of Ghana but not available in other regions of the country.[11]

In our baseline specification, we interact these price shocks with an indicator variable for whether cocoa is produced in the respondent's region of birth. The data on cocoa production that we use to produce this baseline measure are computed directly from the EGC-ISSER Socioeconomic Panel Survey. These data were collected by the Economic Growth Center at Yale University and the Institute for Statistical, Social, and Economic Research at the University of Ghana, Legon.

The data consist of a single cross section, collected between November 2009 and April 2010, covering all of Ghana. Individuals were asked to list all plots of land and what crops were grown on these plots. In figure 2, we present a map of Ghana in which the 10 regions are shaded according to the percentage of farm acreage devoted to cocoa growing. As a robustness check, we discard Greater Accra and Volta from the analysis, as less than 20 percent of farmland in these regions is planted to cocoa.

[11] Note that whereas the global export price of cocoa might be the first choice as a measure of an exogenous determinant of household incomes in cocoa-growing regions, such a price series may not reflect the true, farm gate price faced by cocoa-growing households and is also unavailable for the full range of birth years in the household sample.

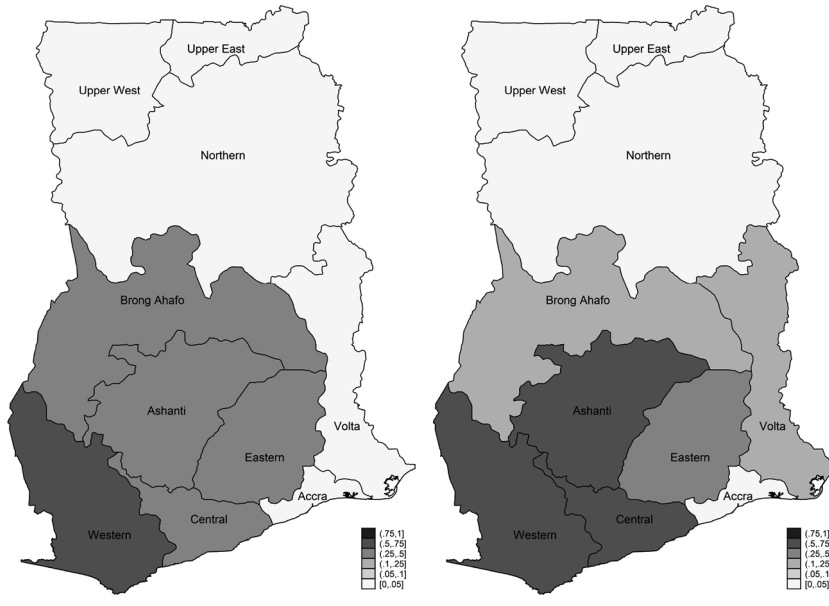

FIG. 2.—Cocoa production and cocoa-suitable soils by region. The figure on the left depicts the fraction of land in the EGC-ISSER survey planted to cocoa in each region. The figure on the right depicts the share of all land in the region that is suitable for cocoa.

Our baseline measure is an indicator for the presence of cocoa in a region. This overlaps closely with the area classified as suitable for cocoa production in the 1958 Survey of Ghana Classification Map of Cocoa Soils for Southern Ghana. Produced for the Survey of Ghana, this map classified ochrosols, oxysols, and intergrades as suitable for cocoa production, conditional on climatic suitability. We plot the fraction of households in each region that grow cocoa (left panel) and the fraction of land in the region suitable for cocoa production (right panel) in figure 2. The similarity between the maps in the two panels validates our classification of regions into cocoa producing and non–cocoa producing.

We focus on regional cocoa production, as opposed to household-level cocoa production measures, for two main reasons. First, as a practical point, while the EGC-ISSER data provide detailed information on cocoa production for the respondent's current household, we do not know the extent of cocoa involvement for the respondent's household at the time of his birth. While the extent of cocoa cultivation at the household level is likely very important in determining exposure to price shocks, this unavailability of data prevents us from exploiting (origin) household-level variation.

Second, focusing on regional exposure is relevant because the value chain for cocoa, because of the nature of the production process, is pre-

dominantly local (Kaplinsky 2004). Cocoa must be fermented and dried shortly after harvest, and these immediately downstream steps are done either on or very close to the area of cultivation (Mohammed, Asamoah, and Asiedu-Appiah 2011). Local processors, haulers, and licensed buying companies all participate in subsequent stages of production, before the cocoa is sold to the central marketing board for export. These downstream agents are thus very likely to be "treated" by price changes, through channels similar to those for cocoa-farming households.

B. Mental Health

Our principal measure of mental health is computed using the 10-question Kessler Psychological Distress Scale, or K10. These data were collected as part of the EGC-ISSER Socioeconomic Panel Survey and are described in greater detail by Canavan et al. (2013). The K10 was developed by Ron Kessler and Dan Mroczek in 1992 as a measure of anxiety-depression spectrum mental distress (Kessler et al. 2002). The questionnaire consists of 10 questions about negative emotional states experienced during the past 4 weeks. Respondents give 5-point answers ranging from "none of the time" to "all of the time." In particular, respondents are asked the following questions:

1. About how often did you feel tired out for no good reason?
2. About how often did you feel nervous?
3. About how often did you feel so nervous that nothing could calm you down?
4. About how often did you feel hopeless?
5. About how often did you feel restless or fidgety?
6. About how often did you feel so restless you could not sit still?
7. About how often did you feel depressed?
8. About how often did you feel that everything was an effort?
9. About how often did you feel so sad that nothing could cheer you up?
10. About how often did you feel worthless?

The survey methodology was developed and first validated in the United States. It has since been administered in a variety of contexts around the world, including in low-income populations in Australia and South Africa (Kilkkinen et al. 2007; Myer et al. 2008). Responses to the K10 have been shown to correlate with the Composite International Diagnostics Interview and with the probability of a mental disorder as defined by the Diagnostic and Statistical Manual for Mental Disorders (Kessler et al. 2003). It is conventional to take a K10 score greater than or equal to 30 as an indicator for severe distress. The K10 measure has been shown to fluctuate with signif-

icant life events, such as changes in employment status and childbirth (Wethington and Kessler 1989). But it is also significantly associated with more long-run components of mental health (see, e.g., Slade, Grove, and Burgess 2011).

In addition to the K10 questionnaire, individuals were asked several additional questions about their mental state. We use these to validate the K10 measures in Section IV. These ask respondents to agree or disagree on a 5-point scale with statements such as "I am someone who is depressed, blue" or "I am someone who is relaxed, handles stress well." We show that responses to these alternative measures of mental health follow the same response to early life shocks as the more structured K10.

We retain individuals for our analysis who were born in Ghana, who have nonmissing responses on the region of birth and K10 questions, who are aged between 15 and 65 at the time of the survey, and whose self-reported ages are consistent with their self-reported years of birth within 5 years. This leaves us with a base sample of 7,741 individuals. We show means for individuals' K10 scores and the indicator for severe distress by region of birth in figure 3. Greater levels of distress correspond to darker shades of gray.

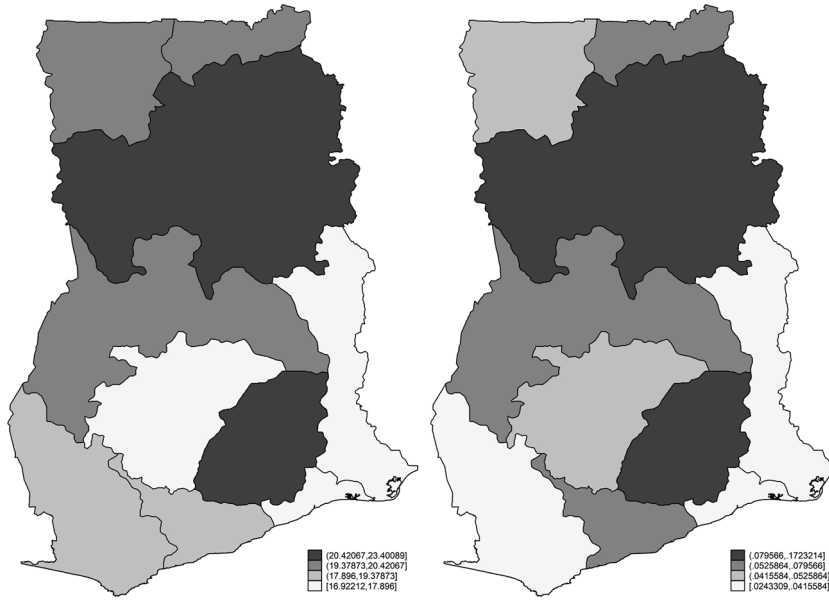

FIG. 3.—Mean K10 score and severe distress by region of birth. The figure on the left depicts the mean K10 score over individuals in the sample. The figure on the right depicts the fraction of respondents whose scores indicate severe distress.

C. *Additional Controls*

The bulk of our additional control variables are taken from the EGC-ISSER data. These include our principal individual controls: fixed effects for region and year of birth, an indicator for female, an indicator for household head, the intersection of female and head, dummies for religion, and dummies for ethnicity.

In addition to these controls, other variables that we interact with early life shocks are also collected from the EGC-ISSER data. These include indicators for whether an individual's father was in agriculture or whether either of an individual's parents had any education. We test whether early life shocks predict additional outcomes also recorded in the EGC-ISSER data, including height in centimeters, BMI, an individual's own education, whether an individual has migrated away from his or her region of birth, and the value of a household's savings.

In a robustness check, we control for rainfall and temperature shocks experienced during a respondent's year of birth. We take data on temperature and rainfall from the standard Willmott and Matsuura series available at http://climate.geog.udel.edu/~climate/. We merge this to the regions of Ghana by taking the average over grid points within a region. Regions not containing a grid point in the climate data are merged to the nearest point.

Finally, we also check for robustness to the inclusion of additional controls for family, economic, and social conditions. These controls, in addition to the age controls subsumed by the birth year fixed effects, are meant to account for changes in mental health measurements due to time-varying sociodemographic factors. The additional controls are number of children in the household, height in centimeters, general health, and dummies for each type of work, marital status, and ability to read English.

D. *Demographic and Health Survey Data*

In Section IV.C, we test several mechanisms that might explain our results. To do this, we make use of additional data from the Ghanaian DHS data sets. These were collected in 1988, 1993, 1998, 2003, and 2008. The data come in three formats:

1. *Individual recodes*: These are nationally representative cross sections of women aged 15–49 at the time of the survey. The surveys contain information on each woman's year of birth, region of residence, years of education, rural residence, age, occupation, partner's occupation, religion, ethnicity, and anthropometric outcomes such as height and weight.

2. *Births recodes*: The women surveyed in the individual recodes are asked to provide a complete history of all births. These data include the child's year of birth, birth order, multiple birth, gender, whether the child is still alive, and if not, how long the child lived. In addition to using these birth histories directly, we reshape them into an artificial panel of data for each woman in the data, recording whether she experienced a birth in each year of life up to age 45.
3. *Children's recodes*: The women surveyed in the individual recodes are also asked a detailed set of questions about all births within the last 5 years. Like the births recodes, these contain information on the child's year of birth, birth order, multiple birth, gender, and the child's current age in months. Crucially, mothers are asked about early life investments such as the vaccination histories of these children and how long they were breast-fed. Mothers are also asked about prenatal investments, such as visits to doctors, additional vaccines, and the circumstances of the delivery of the child.

E. Census Data

In Section IV.C, we evaluate additional mechanisms that might further account for our results. In particular, we use the 2000 and 2010 waves of the Ghanaian census in order to measure both living standards and human capital. Both surveys were carried out by the Ghana Statistical Service. The population universe for the 2000 census included all persons in households and living quarters in Ghana at midnight on census night; in 2010 this was expanded to include those in institutions and in transit, including the floating population. The 2000 census was conducted by direct enumeration using a single form, while the 2010 census was also conducted by direct enumeration with separate forms for household members and nonmembers. Both were sampled using a systematic sample of every tenth dwelling, restricted to private dwellings in 2000.

We use the versions of these data made available by the Integrated Public Use Microdata Series (i.e., IPUMS-International). These are 10 percent samples. Together, we have data on 4,360,422 individuals across these two waves of the census, though restricting to those aged 15–65, as in our baseline analysis, leaves us with a maximum sample of 2,442,682. Like the EGC-ISSER data, the census reports region of birth and year of birth, allowing us to construct our baseline measure of cocoa price exposure in these samples. Further, these data report the same variables we use as controls in our main analysis: female, head, the interaction of female and year, urban, religion, and ethnicity. In addition, we will control for survey year.

The measures of living standards we consider are indicators for whether the respondent's dwelling has electricity and for whether the respondent's dwelling has piped water. We use three measures of human capital:

whether the respondent speaks English, whether the respondent is literate, and the respondent's years of schooling.

F. Summary Statistics

Summary statistics on our variables of interest and principal controls are presented in table 1. The statistics show that there is a great deal of variability in mental health. The mean respondent has a mean K10 score of 19.44, and the mean of the ln(K10) score is 2.92. The median K10 score is similar, at a corresponding value of 18. This is equivalent to a respondent who replies "a little of the time" to eight of the 10 items in the questionnaire. According to the K10, 20.14 percent of our respondents are classified as "moderately distressed." These respondents have a score of at least 25. A respondent who replied "some of the time" to eight of 10 questions would meet this cutoff. Of the sample, 7.4 percent appear severely distressed. These are individuals who score 30 and above. These rates are

TABLE 1
SUMMARY STATISTICS

	Mean (1)	Standard Deviation (2)	Minimum (3)	Maximum (4)	Observations (5)
Mental health:					
ln K10	2.92	.31	2.30	3.91	7,815
Severe distress	.074	.26	0	1	7,815
Cocoa price shocks:					
ln(cocoa price) × region any cocoa: year of birth	3.30	2.01	0	5.52	7,741
Controls:					
Female	.55	.50	0	1	7,815
Year of birth	1973	13.7	1943	1997	7,815
Head	.49	.50	0	1	7,815
Female × head	.15	.36	0	1	7,815
Real producer price series (1943–97):					
Real cocoa price	105	60.1	31.1	251	55
ln(cocoa price)	4.50	.55	3.44	5.52	55
Fraction of farm area under cocoa, by region (%):					
Ashanti	44.36				
Brong Ahafo	31.80				
Central	34.51				
Eastern	26.20				
Greater Accra	.09				
Northern	.00				
Upper East	.00				
Upper West	.00				
Volta	4.38				
Western	53.95				

SOURCE.—EGC-ISSER Socioeconomic Panel Survey and Teal (2002).

similar to those experienced in rural Australia and in South Africa (Kilkkinen et al. 2007; Myer et al. 2008). We show a histogram of K10 scores in figure C.4 in the appendix.

Although cocoa prices in the first decades of the twentieth century were higher than those experienced by our birth cohorts (1943–97), the real producer price of cocoa does fluctuate substantially in our sample. The maximum observed price is eight times the minimum and more than twice the mean. As indicated in figure 2, cocoa production is concentrated in southwestern Ghana.

Our mean respondent was born in 1973. Seventeen percent of the sample is Muslim, 7 percent follows a traditional religion, 5 percent follows no religion, and the remainder is divided almost entirely among several Christian denominations. Roughly 70 percent of our respondents ever attended school. Thirty-seven percent report that their fathers had any education, while 20 percent report the same for their mothers. Two-thirds have a father who worked in agriculture. Roughly half the sample was not born in their current village of residence. Eighty-two percent of people live in their region of birth (of the 10 regions of Ghana). Of those born in a noncocoa region, 85 percent are still in a noncocoa region. Of those born in a cocoa region, 98 percent are still in a cocoa region.

IV. Results

A. *Mental Distress*

We report our main estimates of equation (1) in table 2. There is a negative impact of the price shock at birth on the log of the respondent's K10 score in adulthood. This effect is statistically significant once time trends are added for each region of birth and survives the addition of individual controls. The negative effect of cocoa prices on severe mental distress is robust across specifications. As discussed in Section II, the most rigorous specifications including region of birth time trends and individual controls, reported in columns 3 and 6, are the preferred specifications.[12]

The magnitudes of the effects on the log of the K10 score are moderate, while the impacts on severe distress are large. The real producer price of cocoa has varied widely over time, and a one standard deviation increase in the log price is equivalent to 0.55 log points. In column 3, this would reduce the log K10 score for an individual born in a cocoa-producing region by $-0.045 \times 0.55 = 0.025$. This is roughly 0.08 standard deviations, or

[12] The addition of region of birth trends likely has two competing effects on precision. On the one hand, these trends absorb noise over time at the region of birth level; this should increase precision. On the other hand, they further restrict the variation used to identify treatment effects; this should decrease precision. In our context, the latter effect seems somewhat to outweigh the former.

TABLE 2
IMPACTS OF YEAR OF BIRTH: PRICE SHOCK ON MENTAL DISTRESS

	ln(K10)			SEVERE DISTRESS			SEVERE DISTRESS (Logit Marginal Effects)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Price shock (YOB)	−.023	−.045**	−.045**	−.052***	−.061***	−.062***	−.021**	−.033***	−.031**
	(.016)	(.022)	(.022)	(.016)	(.022)	(.022)	(.010)	(.013)	(.012)
Standard errors clustered by:									
ROB	(.021)	(.016)	(.016)	(.005)	(.014)	(.013)			
YOB	(.012)	(.019)	(.018)	(.013)	(.018)	(.019)			
Cameron et al.: enumeration area and YOB	(.014)	(.020)	(.019)	(.013)	(.019)	(.020)			
Cameron et al.: ROB and YOB	(.021)	(.019)	(.019)	(.005)	(.021)	(.018)			
Moulton: ROB	(.015)	(.020)	(.020)	(.013)	(.018)	(.018)			
Moulton: YOB	(.015)	(.020)	(.020)	(.013)	(.018)	(.018)			
Wild cluster bootstrap	(.019)	(.025)	(.027)	(.027)	(.034)	(.034)			
Observations	7,741	7,741	7,741	7,741	7,741	7,741	7,740	7,740	7,710
YOB fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ROB fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ROB trends	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes	No	No	Yes
Outcome mean: noncocoa regions	3.04	3.04	3.04	.12	.12	.12	.12	.12	.12
Outcome mean: cocoa regions	2.88	2.88	2.88	.060	.060	.060	.060	.060	.060

NOTE.—Standard errors clustered by enumeration area are in parentheses, unless otherwise indicated. Number of enumeration areas per region ranges between 12 and 60. All regressions are ordinary least squares (OLS). Controls are female, head, female × head, ethnicity dummies, and religion dummies, unless otherwise indicated. YOB indicates year of birth (accounts for both nonlinear trends in unobservables at the country level and well-established associations between age at survey and mental health). ROB indicates region of birth.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

1 percent of the mean.[13] For severe distress, a one standard deviation price shock leads to a roughly 3 percentage point reduction in severe distress, which is nearly half the mean.[14] Finally, in columns 7–9, we report marginal effects from a logit specification for severe distress. The estimates are roughly half the magnitude of those from the linear probability model but are still significant and relatively large as compared to the mean levels of severe distress.

We also report in table 2 alternative estimates of the standard error of the impact of the price shock. First, we report standard errors clustered by region of birth or by year of birth. Second, we report Cameron et al. (2011) standard errors clustered by both enumeration area and year of birth or by both region of birth and year of birth. Third, because the number of possible regions of birth is small, we report Moulton-corrected standard errors clustered by year of birth or by region of birth (see Angrist and Pischke 2008). Finally, we also calculate wild cluster bootstrap standard errors (Cameron, Gelbach, and Miller 2008). Our estimates of the standard error do not change noticeably across specifications and do not affect which coefficients are significant at conventional levels.

B. Personality Outcomes

We show in table 3 that, in addition to mental health as measured by the K10 questionnaire, the impact of early life cocoa price shocks is apparent for a variety of similar outcomes. This helps establish the validity of the K10 as a measure of mental illness and the statistical robustness of our results.

First, individuals who received beneficial cocoa price shocks in their year of birth are less likely to report that they are the sort of person who is depressed, or "blue." Similarly, they are more likely to self-identify as relaxed. They are less likely to state that they tend to start quarrels, are disorganized, are moody, or are cold and aloof. These are traits we would expect from individuals who are less likely to experience mental distress as a result of favorable early life events. These personality results are generally robust across specifications and are statistically significant at conventional levels, particularly in the preferred specification reported in columns 3 and 6.

Similarly, although the K10 questions are designed to be used as an index, we show in appendix B.2 that several individual components respond to early life cocoa prices. That is, the results on K10 scores and severe distress are not driven primarily by responses to singular questions.

[13] As a comparison, this is about a quarter of the magnitude of the psychological impact of transitioning to full-time nonemployment ("homemaker") status for women in a developed country context (Wethington and Kessler 1989).

[14] Indeed, this impact accounts for essentially the entire difference in the outcome mean across cocoa and noncocoa regions.

TABLE 3
IMPACTS OF YEAR OF BIRTH PRICE SHOCK ON RELATED PERSONALITY OUTCOMES

	(1)	(2)	(3)	(4)	(5)	(6)
	I am someone who is depressed, blue			I am someone who is relaxed, handles stress well		
Price shock (YOB)	−.223***	−.278***	−.280***	.168***	.121	.142*
	(.065)	(.090)	(.089)	(.060)	(.077)	(.074)
Observations	6,973	6,973	6,973	7,005	7,005	7,005
Outcome mean	2.01	2.01	2.01	3.73	3.73	3.73
	I am someone who starts quarrels with others			I am someone who tends to be disorganized		
Price shock (YOB)	−.085**	−.087*	−.100*	−.235***	−.134*	−.141*
	(.039)	(.052)	(.052)	(.058)	(.078)	(.077)
Observations	6,998	6,998	6,998	6,987	6,987	6,987
Outcome mean	1.29	1.29	1.29	1.66	1.66	1.66
	I am someone who can be moody			I am someone who can be cold and aloof		
Price shock (YOB)	−.254***	−.261***	−.275***	−.248***	−.288***	−.292***
	(.068)	(.092)	(.091)	(.064)	(.092)	(.092)
Observations	6,989	6,989	6,989	7,000	7,000	7,000
Outcome mean	2.12	2.12	2.12	2.18	2.18	2.18
YOB fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
ROB fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
ROB trends	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes

NOTE.—Standard errors clustered by enumeration area are in parentheses, unless otherwise indicated. All regressions are OLS. Controls are female, head, female × head, ethnicity dummies, and religion dummies, unless otherwise indicated.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

C. Mechanisms

1. Agricultural Incomes

First, we provide additional evidence that the year of birth price shocks are indeed operating through parental income at the time of birth. We show evidence in table 4 that the impacts of the price shock on adult mental health are strongest among children of farmers and among the Akan, the ethnic group most associated with cocoa production. In columns 1 and 2 of table 4, we also explore heterogeneity by gender and find little difference in effects across male and female respondents.

2. Mediation Analysis: Wealth, Occupation, Literacy, and Health

Next, we focus our attention on the set of related outcomes available in the main EGC-ISSER data. The candidate mediating factors available to

TABLE 4
HETEROGENEOUS IMPACTS ON MENTAL DISTRESS

	ln(K10) (1)	Severe Distress (2)	ln(K10) (3)	Severe Distress (4)
	Interact with "Female"		Interact with "Father in Agriculture"	
Price shock (YOB)	−.046**	−.063***	−.042*	−.052**
	(.022)	(.022)	(.022)	(.023)
Shock × interaction	.000	.005*	−.010	−.009*
	(.003)	(.003)	(.006)	(.005)
Observations	7,741	7,741	7,047	7,047
Mean of interaction variable	.552	.552	.655	.655
Outcome mean	2.92	.074	2.92	.074
Additional regressors	YOB and ROB fixed effects; ROB trends; controls			
	Interact with "Akan"		Baseline Specification	
Price shock (YOB)	−.034	−.048**	−.045**	−.062***
	(.023)	(.022)	(.022)	(.022)
Shock × interaction	−.020*	−.021***		
	(.012)	(.008)		
Observations	7,719	7,719	7,741	7,741
Mean of interaction variable	.444	.444		
Outcome mean	2.92	.074	2.92	.074
Additional regressors	YOB and ROB fixed effects; ROB trends; controls			

NOTE.—Standard errors clustered by enumeration area are in parentheses, unless otherwise indicated. All regressions are OLS and include the uninteracted "interaction" variable. Controls are female, head, female × head, ethnicity dummies, and religion dummies, unless otherwise indicated.

* Significant at 10 percent.
** Significant at 5 percent.
*** Significant at 1 percent.

us in the EGC-ISSER are cash savings, value of physical assets (e.g., durables, livestock), self-employment, English literacy, BMI, and height. Though measures for some candidate mediators such as investment in childhood and adolescence are missing from this set of variables (as they are not measured for the adult sample for whom we have mental health outcomes), the candidate mediators we are able to explore cover many of the most obvious channels of impact such as economic welfare, education, and both stock of health and acute symptoms. These are all measured at the same point in adulthood as mental distress outcomes.

The mediation analysis presented here (following the methodology developed in Heckman, Pinto, and Savelyev [2013] with an application of inverse probability weighting suggested by Huber [2014]) involves estimating the degree to which impacts of shocks on mental distress vary by values of the candidate mediating factors, in addition to the impacts of shocks on these factors directly.[15]

[15] The three key assumptions for identifying the indirect effect of a treatment through mediators as well as the direct effect are outlined and discussed clearly in Huber, Lechner,

Using these two sets of estimation results along with the main results for impacts of shocks on mental distress (all reported in table 5), we can calculate the contribution of each mediating factor to the total treatment effects on the two mental distress outcomes.[16]

Figure 4 shows the percentage contribution of each of the mediating factors to the total treatment effects on severe distress and the log K10 score.[17] All nonbinary mediating variables (i.e., cash savings, physical assets, BMI, and height) are standardized for ease of comparison.

The results indicate that economic mediators such as cash savings and self-employment seem to contribute more to the total treatment effect than do literacy and health mediators such as adult height and BMI. Additionally, cash savings mediates the effect on mental distress more strongly than does the value of physical assets. Self-employment appears to contribute to treatment effects on mental distress most strongly with a percentage contribution equivalent to a more than three standard deviation change in cash savings. The contribution of self-employment is also the most precisely estimated (one-sided p-values are reported in parentheses under estimated contributions in table 5).

All six mediating factors together account for roughly 10 percent of total treatment effects on both severe distress and ln(K10). The remaining 90 percent of the treatment effects on mental distress outcomes either is the direct effect of the shock or is mediated through other channels not measured for this adult sample in the EGC-ISSER data. On the one hand, restricting attention to additional outcomes in the same data set as our main results allows us to calculate the contribution of each of these additional outcomes to the total treatment effect estimated on mental distress, in addition to ensuring the strongest internal validity of the relationship implied between these outcomes by such a mediation analysis.

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and Mellace (2016). They are conditional independence of treatment, conditional independence of the mediator, and common support. While the first assumption is the same as the identifying assumption in the main analysis of this paper (i.e., that the cocoa price shock at the time of birth is exogenous), the conditional independence of the mediator does not necessarily hold. To address this concern, we follow Huber (2014) in constructing inverse probability weights from the probability of treatment as a function of the full set of candidate mediators and any covariates. We use these weights in all regressions reported in table 5. Finally, we check that none of the mediators perfectly predicts treatment to ensure that common support is not violated.

[16] Note that we abstract away from the treatment of measurement error that is well developed in Heckman et al. (2013), primarily because we lack the multiple measures for each factor required to implement the three-step procedure developed in that study. Of the several frontier mediation analysis methods reviewed in Huber et al. (2016), the inverse probability weighting procedure we employ performs as well as or better than other methods under the circumstances presented in our context.

[17] Note that the contributions reported in fig. 4 correspond to total treatment effects reported in table 5 but differ from the main results reported in table 2. The reason is that we transform the shock variable to a binary for the shock falling above its region-specific mean in order to simplify the calculation of the contribution of each mediating factor.

TABLE 5
IMPACTS OF YEAR OF BIRTH PRICE SHOCKS (BINARY) ON ADULT OUTCOMES AND THEIR CONTRIBUTION TO TOTAL TREATMENT EFFECTS

	ln(K10) (1)	Severe Distress (2)	Cash Savings (3)	Physical Assets (4)	Self-Employed (5)	Literacy (6)	Height (7)	BMI (8)
Binary shock × cash savings	−.0220***	−.0243***						
	(.0067)	(.0058)						
Binary shock × physical assets	.0013	.0045						
	(.0087)	(.0074)						
Binary shock × self-employed	−.0659***	−.0658***						
	(.0244)	(.0226)						
Binary shock × literacy	−.0301	−.0219						
	(.0263)	(.0222)						
Binary shock × BMI	.0011	−.0086						
	(.0113)	(.0117)						
Binary shock × height	−.0056	.0070						
	(.0110)	(.0096)						
Binary price shock (YOB)	.0922	−.0838	.0552	.0880	.0650**	.0284	.0855	−.0255
	(.2235)	(.2012)	(.0855)	(.0874)	(.0308)	(.0363)	(.0729)	(.0547)
Observations	7,324	7,324	7,324	7,324	7,324	7,324	7,324	7,324
Outcome mean	2.92	.074	.195	.389	.637	.470	5.352	5.352
Additional regressors	YOB and ROB fixed effects; ROB trends; controls							

	Total Treatment Effect							
Binary price shock (YOB)	−.0638**	−.0573**						
	(.0251)	(.0263)						
Percent contribution to total effect on ln(K10)			1.9055	−.1810	6.7090*	1.3386	.7447	.0425
			(.2865)	(.9425)	(.0805)	(.261)	(.326)	(.4625)
Percent contribution to total effect on severe distress			2.3423	−.6976	7.4688*	1.0855	−1.0475	−.3818
			(.29)	(.8165)	(.0785)	(.2595)	(.2685)	(.358)
Observations	7,324	7,324						
Outcome mean	2.92	.074						
Additional regressors	YOB and ROB fixed effects; ROB trends; controls							

NOTE.—Standard errors clustered by enumeration area are in parentheses, unless otherwise indicated. For analytical tractability in the mediation analysis, the YOB price shock has been transformed to a binary variable taking value one if the price in the region of birth fell above the region-specific mean during the individual's YOB. Cash savings, physical assets, height in centimeters, and BMI are transformed into standard deviation units for ease of comparison. Self-employed and literacy are binary variables and are not transformed. All regressions are OLS. Controls are female, head, female × head, ethnicity dummies, and religion dummies, along with all mediator variables wherever these variables are not outcomes.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

However, the EGC-ISSER data preclude us from commenting on a broader array of mechanisms (e.g., parental health, early life investments) that are not measured for the adult cohort for whom we have mental health outcomes. Additionally, the relatively small sample size of the EGC-ISSER (as compared to the DHS and Ghanaian census, which are between 1.5 and 300 times as large) limits the power of this empirical exercise.

Accordingly, we also explore below impacts of price shocks on parental health and early life investments using the DHS and on assets and education using the 2000 and 2010 waves of the Ghanaian census. These alternative data sets allow us to explore additional outcomes and potential channels of impact but lack the main mental distress outcomes of interest and so cannot be used to expand the formal mediation analysis presented above. While the Ghanaian census in fact does attempt to measure mental distress, the questions pertain only to extreme conditions and are reported to be present in less than 1 percent of the population. These measures are not comparable to those in the EGC-ISSER and show no clear pattern of impact from the shock. This is potentially due to the fact that the price shock we study offers more moderate variation than, for example, extreme caloric deprivation, so impacts on extreme mental health outcomes may be small.

3. Investments

We next investigate the role of early life investments in the child as a mediating mechanism for our main results. Adult outcomes of children born during cocoa booms might be affected by investments made after birth such as duration of breast-feeding and vaccinations. Investments, even if they are made after birth, might be affected by year of birth price shocks by way of the household's intertemporal budget. Investments may also respond to the child's endowment, which was augmented by the year of birth shock.[18]

We are able to use the DHS children's recodes to test whether a broad number of investments respond to cocoa price shocks. We estimate

$$\begin{aligned}\text{Investment}_{irt} = {} & \alpha + \beta \ln(\text{Cocoa Price}_t) \times \text{Cocoa Producer}_r \\ & + x'_{irt}\gamma + \delta_r + t_r + \eta_t + \epsilon_{irt}.\end{aligned} \tag{2}$$

Here, Investment_{irt} is a measure of investment in child i, living in region r, and born in year t. Examples include the duration of breast-feeding

[18] Indeed, parents may have strong incentives to reinforce shifts in infants' endowments if the production of child health exhibits complementarities in investments across different periods of childhood (Heckman 2007).

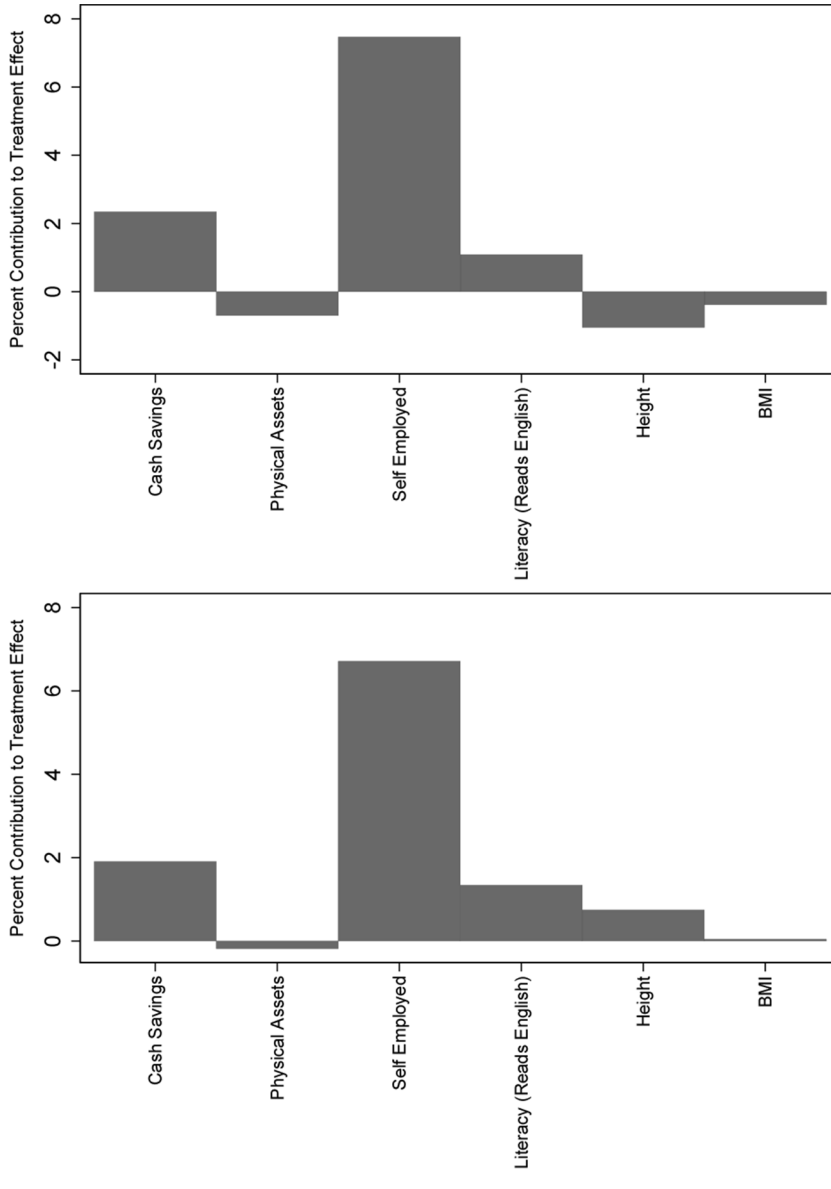

FIG. 4.—Mediation analysis. This figure depicts contributions of mediating factors to total treatment effects as calculated from regression results reported in table 5. The methodology for conducting this mediation analysis follows a special case of the procedure presented in Heckman et al. (2013) along with an application of inverse probability weighting developed in Huber (2014) to address concerns of endogeneity in the mediating variables.

and receipt of various vaccinations. The cocoa price shock variable $\ln(\text{Cocoa Price}_t) \times \text{Cocoa Producer}_r$ is measured in the child's year of birth. The term δ_r is a vector of region fixed effects, t_r is a vector of region-specific time trends, η_t is a vector of year of birth fixed effects, and α is an intercept. The vector of controls x_{irt} includes both maternal characteristics (years of education, rural, mother's age, mother's age squared, dummies for religion, and dummies for ethnicity) and predetermined child characteristics (birth order, multiple birth, female, and age in months at time of survey).[19] Standard errors are clustered by region.

In our selection of investment outcomes, we follow Adhvaryu and Nyshadham (2016), who find evidence that parents reinforce stronger endowments with more investment. Specifically, we estimate impacts of year of birth price shocks on the number of vaccination doses received and duration of breast-feeding. We also consider at-birth and prenatal investments such as doctor-attended delivery and zero dose vaccinations. The results of these regressions are reported in the top two panels of table 6.

Consistent with the results in Adhvaryu and Nyshadham (2016), we find evidence of reinforcing investment in terms of breast-feeding and vaccinations in early life but little evidence of effects on at-birth or prenatal investments. Estimates reported in the middle panel of table 6 show increases in both vaccinations and breast-feeding. The bottom panel shows some weak evidence of an increase in the likelihood of a prenatal doctor visit but no evidence of an increased likelihood of receiving at-birth vaccination doses (i.e., polio 0 and BCG) nor an increased likelihood of the child being delivered under formal health care. We find no evidence that prenatal investments respond to cocoa prices in the year before birth (not reported).

This pattern is consistent with, but not exclusive to, impacts on investments being driven by responses to improved endowments rather than by budget constraint slackness during cocoa booms.[20] We propose this mechanism on the basis of the following logic. If investment effects were driven by increased incomes, we would expect at-birth and prenatal investments to reflect the increased household income in the child's year of birth. Although not reported here for the sake of brevity, we also regress the same early life investment outcomes on price shocks in the first and second years of the child's life and find no evidence of effects. We interpret this as further evidence against effects on investments being driven by increased incomes.

[19] In app. table A15, we show that results are similar when mother controls are omitted.

[20] We note, however, that because of a lack of data on (1) objective measures of child health and (2) reliable household income measures, we cannot directly test this hypothesis.

4. Parental Health

We then explore the role of parental health during gestation as another mediating mechanism for our results. That is, it is possible that children born during cocoa booms receive greater nutrition during gestation by way of greater maternal nutrition. As discussed above, to test whether early life price shocks operate through greater maternal health, we cannot use the EGC-ISSER data set, because it is a single cross section. Instead, we test whether the observable health outcomes of women in the DHS individual recodes respond to contemporary price shocks. We estimate

$$\begin{aligned} \text{Outcome}_{irt} = \alpha + \beta \ln(\text{Cocoa Price}_t) \times \text{Cocoa Producer}_r \\ + x'_{irt}\gamma + \delta_r + t_r + \eta_t + \epsilon_{irt}. \end{aligned} \tag{3}$$

Here, Outcome_{irt} is a health outcome (weight or BMI) for woman i, living in region r in year t. The cocoa price shock variable $\beta \ln(\text{Cocoa Price}_t) \times \text{Cocoa Producer}_r$ is measured in year t. The term δ_r is a vector of region fixed effects, t_r is a vector of region-specific time trends, η_t is a vector of year fixed effects, and α is an intercept. The vector of controls x_{irt} includes years of education, rural, age, age squared, dummies for religion, and dummies for ethnicity. Standard errors are clustered by region. We discard outliers with reported weights outside the range 35–140 kilograms and BMIs outside the range 15–35. Columns 1 and 2 of the third panel in table 6 show that parental weight and BMI are improved by contemporaneous positive cocoa price shocks. We interpret these results as evidence of maternal nutrition as a channel for the estimated impacts of early life income shocks on adult mental health.

5. Other Adult Outcomes

Finally, we also explore the degree to which impacts on mental health and personality traits are accompanied by impacts on other outcomes in adulthood. Having explored the set of related adult outcomes available in the EGC-ISSER in the mediation analysis above, we investigate adult outcomes in additional data sets here to enrich the analysis. Specifically, we regress respondent's occupation from the DHS and measures of assets (dwelling quality) and human capital accumulation (English, literacy, and years of schooling) from the Ghanaian census on the same year of birth price shocks using the same specification as reported in columns 3 and 6 of tables 2 and 3. These results are reported in the bottom two panels of table 6 and indeed show impacts on all of these categories of outcomes. Specifically, we find (imprecisely estimated) positive impacts on labor force participation and substantial impacts on agricultural self-employment for respondents in the DHS. The census results show positive

TABLE 6
OTHER ADULT OUTCOMES, MATERNAL HEALTH, AND INVESTMENT RESPONSES (DHS and Ghanaian Census)

	(1)	(2)	(3)	(4)	(5)
	Early Life Investments (DHS: Child Recode)				
	No. of Polio Doses Received	No. of DPT Doses Received	Received Measles Vaccination	No. of Total Vaccinations	Months of Breast-Feeding
Price shock (YOB)	.218**	.317***	.034	.528***	.989*
	(.076)	(.063)	(.054)	(.137)	(.511)
Observations	11,903	11,829	11,809	11,725	13,134
Outcome mean	2.25	2.24	.65	5.14	14.9
	Prenatal and At-Birth Investments (DHS: Child Recode)				
	Prenatal Doctor Visit	Received BCG Vaccination	Received Polio 0 Dose	Home Delivery	Doctor Attended Delivery
Price shock (YOB)	.085*	−.034	−.010	.028	−.017
	(.042)	(.042)	(.107)	(.066)	(.021)
Observations	9,582	11,886	9,067	11,101	11,090
Outcome mean	.22	.85	.49	.55	.073
	Maternal Health (DHS: Individual Recode)			Occupation (DHS: Individual Recode)	
	Weight (No Outliers)	BMI (No Outliers)		Not Working (DHS)	Agricultural Self-Employment
Price shock (YOB)				−.036	.065***
				(.021)	(.008)
Contemporaneous price shock	3.538***	1.044***			
	(.861)	(.319)			
Observations	14,411	14,022		19,831	19,831
Outcome mean	57.5	22.5		.23	.294

	Other Outcomes (Ghanaian Census: 2000 and 2010)				
	Dwelling Has Electricity	Dwelling Has Piped Water	Speaks English	Literate	Years of Schooling
Price shock (YOB)	.011**	.012**	.015***	.017***	.462***
	(.005)	(.005)	(.005)	(.005)	(.048)
Observations	2,367,613	2,367,687	2,410,404	2,410,404	2,410,407
Outcome mean	.55	.43	.63	.68	6.51
Additional regressors	YOB and ROB fixed effects; ROB trends; controls				

NOTE.—Standard errors clustered by region are in parentheses unless otherwise indicated. All regressions are OLS. Controls in the individual recode are years of education, rural, age, age squared, dummies for religion, and dummies for ethnicity. Controls in the child recode with year of birth shocks are maternal characteristics (years of education, rural, mother's age, mother's age squared, dummies for religion, and dummies for ethnicity) and predetermined child characteristics (birth order, multiple birth, female, and age in months at time of survey). Controls in the individual recode with contemporary shocks are years of education, rural, age, age squared, dummies for religion, and dummies for ethnicity. Controls in the Ghanaian census specifications are dummies for gender, household head, gender by head, urban, religion, ethnicity, and census year. Standard errors in these census specifications are clustered by district of survey.

* Significant at 10 percent.

** Significant at 5 percent.

*** Significant at 1 percent.

impacts on both dwelling quality (electricity and piped water) and human capital accumulation (English, literacy, and years of schooling). We interpret these results as supporting evidence that impacts on mental health are coincident with improved labor, education, and economic outcomes.

As discussed above, though these estimates from alternative data sets of impacts of shocks on related outcomes and candidate mediating factors help to reinforce the evidence from the mediation analysis conducted above, they cannot themselves be included in a proper mediation analysis. As broad surveys such as the Ghanaian census begin to collect measures of mental health, we hope that future research can extend significantly the meditation analysis conducted here.

V. Conclusion

In this study, we estimate the impacts of early life income shocks on adult mental health. We show, among a nationally representative sample of households in Ghana, that a one standard deviation increase in the cocoa price in early life reduces the likelihood of severe mental distress in later life by roughly 3 percentage points for individuals born in cocoa-producing regions relative to the same birth cohort born in other regions. This is nearly half the mean.

Recent studies from the mental health literature have estimated that treatment, by either medication or therapy, can reduce the prevalence of mental distress by between 70 and 93.5 percent in low-income countries (Patel et al. 2007). We show that insulating households from a one standard deviation drop in agricultural output prices can reduce the prevalence of mental distress by roughly 50 percent. Given that studies have calculated the cost effectiveness ratio of treatment of mental disorders in low-income settings to be US$500–$1,000 per averted disability-adjusted life-year (Patel et al. 2007), roughly commensurate with treatment and prevention of chronic illness such as HIV/AIDS and diabetes, policies to protect households against income fluctuations as a means of preventing later-life mental distress might prove relatively more cost effective. This argument is likely made even stronger once the economic costs of mental distress are more comprehensively measured.

In addition to being direct determinants of utility, psychological traits have been linked to physical and economic health and decision making in adults (Heckman and Rubinstein 2001; Heckman et al. 2006). That is, psychological well-being is important both as an outcome in its own right and as a potential mechanism for some of the large, later-life impacts of early life factors measured in the literature to date. As Heckman (2006, 2007) and Cunha et al. (2010) have recently shown, personality outcomes are formed early and are likely greatly influenced by factors in early life. We demonstrate that these impacts continue to persist in the long

run, suggesting that intervention at early ages to blunt the effects of trauma (economic and otherwise) could spare some fraction of adults from severe psychological distress and its economic consequences.

Our results suggest two mutually compatible interpretations of the impacts on mental health. First, mental health could be a mechanism that partly explains other economic impacts of early life shocks. Second, mental health is a final outcome that depends partly on these economic and health-related outcomes. In this case, the indirect effects of health and economic welfare on mental illness would be in addition to direct effects we have estimated. Previous measurements of the welfare importance of early life factors, while already large, are underestimated to the degree that they do not include mental health.

This study complements a growing set of studies in the development economics literature that regard economic outcomes as incomplete measurements of welfare (Devoto et al. 2012; Baird, De Hoop, and Özler 2013; Angelucci, Karlan, and Zinman 2015; Haushofer and Shapiro 2016). Measures such as mental health add to the richness of research on the efficacy of welfare interventions and should be increasingly measured, reviewed, and addressed in policy recommendations. This is particularly true in developing contexts in which these dimensions of welfare have received less attention and resources for improving mental health are most limited.

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